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TECHNICAL (FINAL) REPORT

RESEARCH ON WAVES IN ANISOTROPIC MEDIA

H. MOTZ

OXFORD UNIVERSITY
ENGINEERING LABORATORY,
OXFORD, ENGLAND

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ABSTRACT

1. The radiation impedance of various sources is computed and it is shown that the average Poynting vector has the direction of the group velocity.

2. The one dimensional problem of R-f-confinement was investigated and solved completely by analytic means.

3. Boltzmann's equation was solved by means of dyadic Green's functions to establish a conductivity tensor valid for elevated temperatures.

4. Temperature and collision effects in a plasma were investigated and dispersion surfaces computed.

5. Photo-emission from a tungsten point was obtained with light from a ruby laser.

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In the period under review the research under the grant covered the following aspects:

1. Radiation from sources in a plasma, and the significance of the Poynting vector.

2. R- f- confinement.

3. High temperature conductivity tensor.

4. Temperature and collision effects on wave propagation in a plasma.

5. Action of laser light on surfaces.

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Short stetements on the results will be given now under the different headings with reference to published work or work to be published shortly.

1. Radiation from sources in a plasma, and the significance of the Poynting vector

An invited paper was given by H. Motz on this subject at the Copenhagen Symposium on Electromagnetic Theory and Antennas, and will be published in its proceedings. The substance of the paper is the use of dyadic Green's functions for the calculation of radiation impedances of various sources in a plasma, and the calculation of the far-field. A study of the far-field establishes the fact that the average Poynting vector points in the direction of the group velocity, which itself is normal to the dispersion surface. We include with this report twenty-five copies of a pre-print of this paper.

2. R- f- confinement

A paper was published in the Journal of the Physics of Fluids. In this paper the one-dimensional problem of R-f-confinement is tackled with the help of a new method and various conclusions are established, amongst them an expression for the magnetic field H or electric field E needed for confinement of a plasma with a density n

$$\epsilon_0 E^2 = \mu_0 H^2 = 8\, nkT$$

is derived. Reprints have not yet been received.

3. High temperature conductivity tensor

Mr. Kikuchi has prepared a paper on the subject of the conductivity tensor treating the Boltzmann equation by means of dyadic Green's function methods. The term involving the electric field is singled out as the source term and explicit expressions for the Green's function are derived leading to a conductivity matrix valid in the high temperature approximation.

This paper has not yet been written up for publication. At present it comprises about fifty pages which we shall perhaps reproduce fully as a Technical Report, if we find it necessary to publish an abbreviated version.

4. Temperature and collision effects on wave propagation in a plasma

A Note on the relative importance of collision and temperature effects has been submitted (but not yet accepted) to the Journal of the Physics of Fluids which establishes and interprets the criterion

$$\frac{\lambda}{V} \ll \frac{\lambda_f}{V_\phi}$$

for neglecting collision effects with respect to temperature effects. Here λ is the wavelength of the electro-magnetic radiation, λ_f a mean free path, V_ϕ the phase velocity of the wave and V a molecular velocity.

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Extensive work has been done of the computation of dispersion surfaces taking account of collision and temperature effects.

This will be briefly reported on at the Orsay (Paris) Conference on Ionisation Phenomena in Gases, and, perhaps more fully, in Tokyo. H. Motz has been designated as a British Delegate to the 14th General Assembly of the International Union for Scientific Radio and intends to present some of this work there.

5. Action of laser light on surfaces

A paper on the action of laser light on a surface was presented at the Paris Conference on Quantum Electronics. It shows that electron emission from a tungsten point can be obtained even though the work function of tungsten is much higher than the energy of the individual light quanta.

Further work on this subject will be done. Copies of the paper have been forwarded to the Air Force.